VERIFICATION OF TRANSLATION

I, Timothy S. Price, translator at Nakajima & Matsumura Patent Attorneys Office, 6F Yodogawa 5-Bankan, 3-2-1 Toyosaki, Kita-ku, Osaka, 531-0072, Japan, hereby declare that I am conversant with the English and Japanese languages and am a competent translator thereof. I further declare that to the best of my knowledge and belief the following is a true and correct translation made by me of Japanese Patent Application Publication No. H09-167566 filed on December 15, 1995.

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(54) [TITLE OF THE INVENTION] PLASMA DISPLAY PANEL AND MANUFACTURING METHOD THEREFOR

(57) [ABSTRACT]

[PROBLEM TO BE SOLVED] To provide a PDP (plasma display panel) provided with a protection layer of a dielectric layer capable of lowering a discharge initializing voltage and improving a sputter resistance regarding improvement of the dielectric layer of an AC-type PDP, and a manufacturing method for the PDP.

[SOLUTION] In this PDP, a discharge electrode 2 formed on a front glass substrate 1 is covered by a dielectric layer 3, and a protective layer is provided on this dielectric layer 3. Also, this protective layer is constituted from a laminated structure body of an MgO crystal layer 4 and an MgO vapor-deposited layer 5, and the manufacturing method of this PDP includes the processes of, when forming the above protective layer, forming the MgO crystal layer 4 on a surface of the dielectric layer 3,

thereafter performing ion-cleaning of a surface of the MgO crystal layer 4 and forming the MgO vapor-deposited layer 5 on the surface of the MgO crystal layer 4.

[CLAIMS]

[CLAIM 1] A plasma display panel in which a discharge electrode formed on a substrate is covered by a dielectric layer, and provided with a protective layer on the dielectric layer, wherein

the protective layer is composed of a laminated structure body of an MgO crystal layer and an MgO vapor-deposited layer.

[CLAIM 2] The plasma display panel of claim 1, wherein

the MgO crystal layer is composed of a fine MgO powder, a fine magnesium powder, an organic acid metal salt of magnesium, or a complex thereof.

[CLAIM 3] The plasma display panel of claim 2, wherein

the MgO crystal layer further includes low-melting glass.

[CLAIM 4] A manufacturing method for a plasma display panel, comprising the steps of:

when forming the protective layer of claim 1,

forming the MgO crystal layer on a surface of the dielectric layer;

performing ion-cleaning of a surface of the MgO crystal layer; and

forming the MgO vapor-deposited layer on the surface of the MgO crystal layer.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[FIELD OF THE INVENTION]

The present invention relates to improvements in a protective layer of a dielectric layer of an AC-type plasma display panel (hereinafter, abbreviated as PDP).

[0002]

[DESCRIPTION OF RELATED ART]

With the colorization of PDPs in recent years, AC-type PDPs have come to be used as full-color display devices for TV receivers, and attention is focused particularly on their use as large flat displays for high-definition video.

[0003]

In order to be used in such an application, there is a need for larger PDPs, as well as an increase in definition and the life of the PDP. Due to this situation, there is demand for larger, higher definition, and longer lasting PDPs.

[0004]

[DESCRIPTION OF THE PRIOR ART]

A conventional PDP is described in detail with reference to Fig.4. Fig.4 shows a principal portion of a conventional PDP.

[0005]

As shown in Fig.4, the principal portion of the conventional PDP includes a front glass substrate 11 that is

composed of soda lime glass and has a plate thickness of 3 mm, a plurality of pairs of parallel and adjacent display discharge electrodes 12 formed on a surface of the front glass substrate 11, a dielectric layer 13 that is composed of low-melting glass, has a film thickness of 50 µm, and covers the discharge electrodes 12, and an MgO layer 15 which is a protective film on a surface of the dielectric layer 13 and has a film thickness of 10,000 Å.

[0006]

Although a vapor deposition method is generally used as the formation method for the MgO layer 15, other methods may be used, such as a spray method or application method using a liquid organic acid metal salt, or a fine powder application method which applies a paste that includes a fine MgO powder.

[0007]

Also, address electrodes 17 and belt-like barrier walls (not depicted) delimiting discharge portions are formed parallel to each other on a surface of a back glass substrate 16 that is composed of soda lime glass and has a plate thickness of 3 mm. The back glass substrate 16 is superimposed on the front glass substrate 11 facing an electrode formation surface, a periphery thereof is sealed, and after evacuating a discharge space formed between the substrates, a mixed gas of 99.9% neon (Ne) and 0.1% xenon (Xe) is enclosed in the discharge space as a discharge gas.

[0008]

[PROBLEMS SOLVED BY THE INVENTION]

In the above-mentioned conventional AC-type PDP, the

protective layer is provided due to the need to reduce the discharge initializing voltage so as to increase the secondary emission coefficient γ, and to improve sputter resistance so as to increase the life of the PDP, and an MgO vapor-deposited layer is generally used as the protective layer. When forming this protective layer by the vapor-deposition method, given that the base dielectric film is low-melting glass, an amorphous layer with a film thickness of several thousand Å is formed first, and a crystal layer is formed gradually thereafter. However, as the use time of the PDP grows longer, the crystal layer becomes sputtered, thereby reducing the film thickness, and when the sputter reaches the amorphous layer, the drive voltage rise drastically, surpassing the preset drive voltage, and thereby reaching the end of the life of the PDP.

[0009]

In a non-vapor deposition method such as the spray method or application method using the liquid organic acid metal salt, one process can only form a protective film with a thickness of about 2,000 to 3,000 Å, and gaps appear in a protective layer formed in the fine powder application method that applies a paste including a fine MgO powder.

[0010]

In view of the above situation, an aim of the present invention is to provide a PDP provided with a protective layer of a dielectric layer that is capable of reducing the discharge initializing voltage and improving sputter resistance, and a manufacturing method for the PDP.

[0011]

[MEANS TO SOLVE THE PROBLEMS]

The PDP of the present invention is provided with a protective layer composed of a laminated body of an MgO crystal layer and an MgO vapor-deposited layer.

[0012]

In the present invention, an MgO crystal layer is formed, using a fine MgO powder or an organic acid metal salt including MgO, as a bottom layer of an MgO layer by vapor deposition, thereby enabling a thickening of the MgO crystal layer at the surface of the dielectric layer, and improving crystallinity, which makes it possible to provide a long-lasting PDP with good sputter resistance.

[0013]

[EMBODIMENTS OF THE INVENTION]

Next is a detailed description of a working example of the preset invention with reference to Fig.1 to Fig.3. Fig.1 shows a principal portion of a PDP of the present invention, Figs.2A and 2B show a process order of working examples of manufacturing methods for the PDP of the present invention, and Fig.3 shows a relationship between experimentation time and variations in discharge voltage of the PDP of the present invention.

[0014]

As shown in Fig.1, in the PDP of the present invention, a discharge electrode 2 and a dielectric layer 3 that is composed of low-melting glass and has a film thickness of 50 μm are formed on a surface of a front glass substrate 1 that is composed of

soda lime glass and has a plate thickness of 3 mm, similarly to the conventional example.

[0015]

In accordance with the features of the present invention, a two-layer protective film is formed on a surface of the dielectric layer 3, where the two layers are an MgO crystal layer 4 that has been formed by a screen printing method and heat sintering and has a film thickness of 2,000 Å, and an MgO vapor-deposited layer 5 that has been formed on a surface of the MgO crystal layer 4 and has a film thickness of 8,000 Å.

[0016]

Also, address electrodes 7 and belt-like barrier walls (not depicted) delimiting discharge portions are formed parallel to each other on a surface of a back glass substrate 6 that is composed of soda lime glass and has a plate thickness of 3 mm. The back glass substrate 16 is superimposed on the front glass substrate 1 facing an electrode formation surface, a periphery thereof is sealed, and after evacuating a discharge space formed between the substrates, a mixed gas of 99.9% neon (Ne) and 0.1% xenon (Xe) is enclosed in the discharge space as a discharge gas.

[0017]

Figs.2A and 2B show in detail a process order of manufacturing methods 1 to 5 for this PDP. The manufacturing methods 1 to 5 differ with respect to the formation process for the MgO crystal layer, but other manufacturing processes are the same. The following describes the manufacturing method 1 in detail.

[0018]

First, as shown in Fig.2A, the discharge electrode 2 is formed on the surface of the front glass substrate 1, and after the dielectric layer 3 with a film thickness of 50 μm is formed so as to cover the front glass substrate 1 and the discharge electrode 2, a crystallized fine MgO powder is applied to the surface of the dielectric layer 3 by a screen printing method and dried, and thereafter sintered at 500°C to form an MgO crystal layer 4 with a film thickness of 2,000 Å.

[0019]

Next, as shown in Fig.2B, the MgO vapor-deposited layer 5 with a film thickness of 8,000 Å is formed on the surface of the MgO crystal layer 4 by a vapor-deposition method. Thereafter, as shown in Fig.1, a periphery of the back glass substrate 6 that is composed of soda lime glass, has the address electrode 7 formed thereon, and has a plate thickness of 3 mm, and a periphery of the front glass substrate 1 are sealed, air is evacuated from the discharge space between the front glass substrate 1 and the back glass substrate 6, and a mixed gas of 99.9% neon (Ne) and 0.1% xenon (Xe) is enclosed therein as the discharge gas.

[0020]

In the manufacturing method 2 for the PDP, instead of screen printing the crystallized fine MgO powder as in the manufacturing method 1, the MgO crystal layer 4 with a film thickness of 2,000 Å is formed by applying a paste including an organic acid metal salt of magnesium acetate, magnesium propionate, etc. by a screen printing method, drying, and thereafter performing

sintering at 500°C.

[0021]

In the manufacturing method 3 for the PDP, instead of screen printing the crystallized fine MgO powder as in the manufacturing method 1, the MgO crystal layer 4 with a film thickness of 2,000 Å is formed by applying a mixed paste including a crystallized fine MgO powder and an organic acid metal salt of magnesium acetate, magnesium propionate, etc. by a screen printing method, drying, and thereafter performing sintering at 500°C.

[0022]

In the manufacturing method 4 for the PDP, instead of screen printing the crystallized fine MgO powder as in the manufacturing method 1, the MgO crystal layer 4 with a film thickness of 2,000 Å is formed by applying a mixed paste including a fine MgO powder and low-melting glass by a screen printing method, drying, and thereafter performing sintering at 500°C.

[0023]

In the manufacturing method 5 for the PDP, the MgO crystal layer 4 is formed as in the manufacturing method 1, and an ion gun is used to perform cleaning for about 5 minutes before vapor deposition. Fig.3 shows a relationship between experimentation times and variations in discharge voltage of PDPs manufacturing by the manufacturing methods 1 to 5.

[0024]

As shown in Fig.3, while there was almost no change in variations in discharge voltage of working examples of the present invention until around 1,000 hours of experimentation time, there

was a substantial increase around 1,200 hours, making the effects of the present invention clear.

[0025]

On comparing the working examples of the present invention, the variation in discharge voltage of working example 3 was the lowest, next lowest was the variation in discharge voltage of example 5, in which the ion cleaning step was added to working example 1, and thereafter the variations in discharge voltage increased in the order of working examples 4, 1, and 2.

[0026]

Note that the present invention is not limited to the above-mentioned 3-electrode surface discharge AC-type PDP, and of course can be applied to surface discharge AC-type PDP or an opposing discharge AC-type PDP.

[0027]

[EFFECTS OF THE INVENTION]

As is clear from the above description, the present invention has a benefit of enabling the manufacture of a long-lasting PDP, since according to the present invention it is possible to form a thicker MgO crystal layer at a surface of a dielectric layer, as well as improve crystallinity and sputter resistance, and it is possible to provide a PDP with the effect of a remarkable economic improvement and an improvement in reliability, and a manufacturing method for the PDP.

[BRIEF DESCRIPTION OF THE DRAWINGS]

Fig.1 shows a principal portion of a PDP of the present

invention.

Figs.2A and 2B show a process order of working examples of manufacturing methods for the PDP of the present invention.

Fig.3 shows a relationship between experimentation time and variations in discharge voltage of the PDP of the present invention.

Fig.4 shows a principal portion of a conventional PDP.

[DESCRIPTION OF THE CHARACTERS]

1	front glass substrate
2	discharge electrode
3	dielectric layer
4	MgO crystal layer
5	MgO vapor deposited layer
6	back glass substrate
7	address electrode

FIG. 1

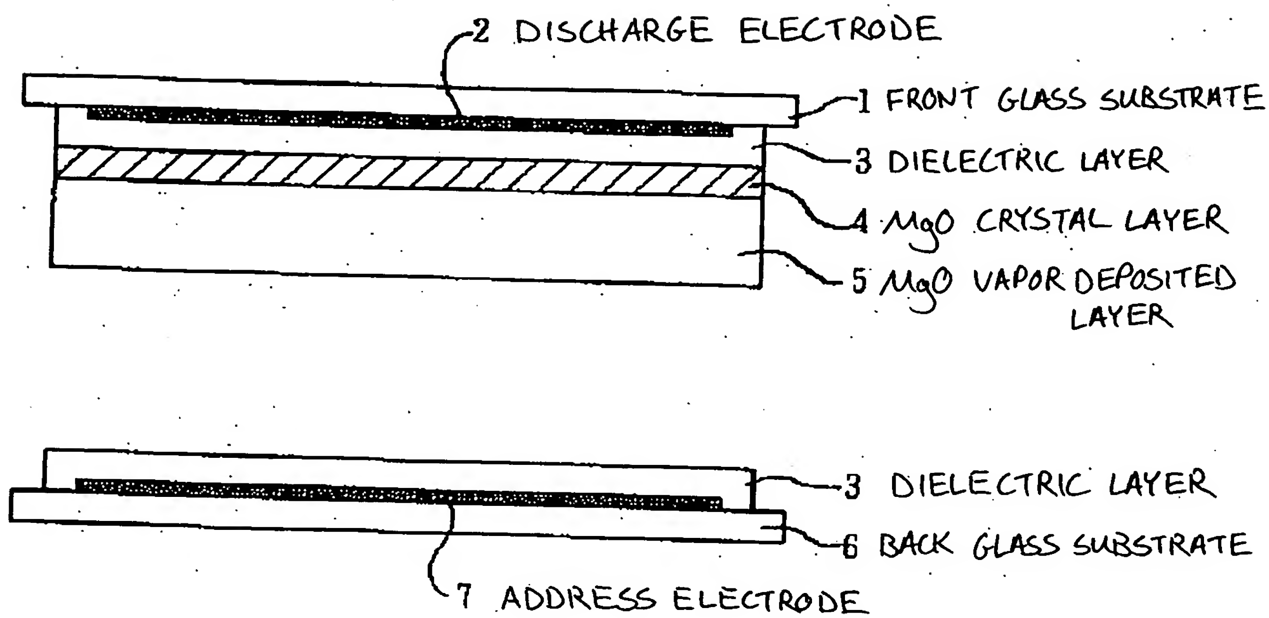
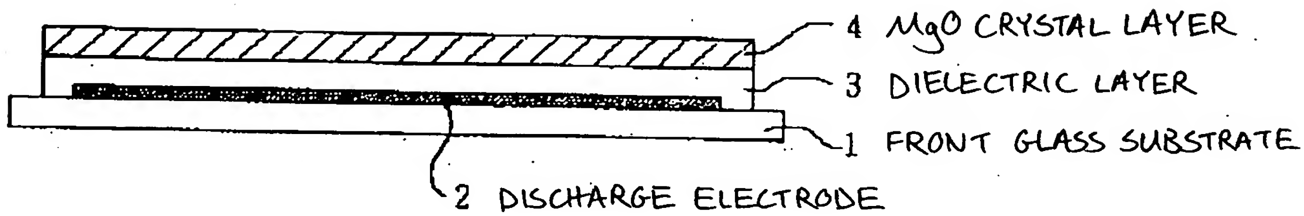

2 DISCHARGE ELECTRODE
1 FRONT GLASS SUBSTRATE
3 DIELECTRIC LAYER
4 MgO CRYSTAL LAYER
5 MgO VAPOR DEPOSITED LAYER
3 DIELECTRIC LAYER
6 BACK GLASS SUBSTRATE
7 ADDRESS ELECTRODE

FIG. 2

(a) FORMATION OF MgO CRYSTAL LAYER (4)



(b) FORMATION OF MgO VAPOR DEPOSITED LAYER (5)

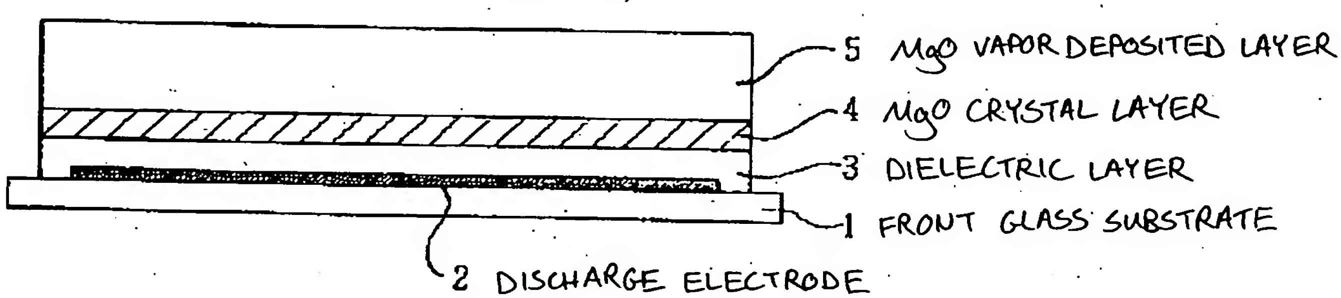
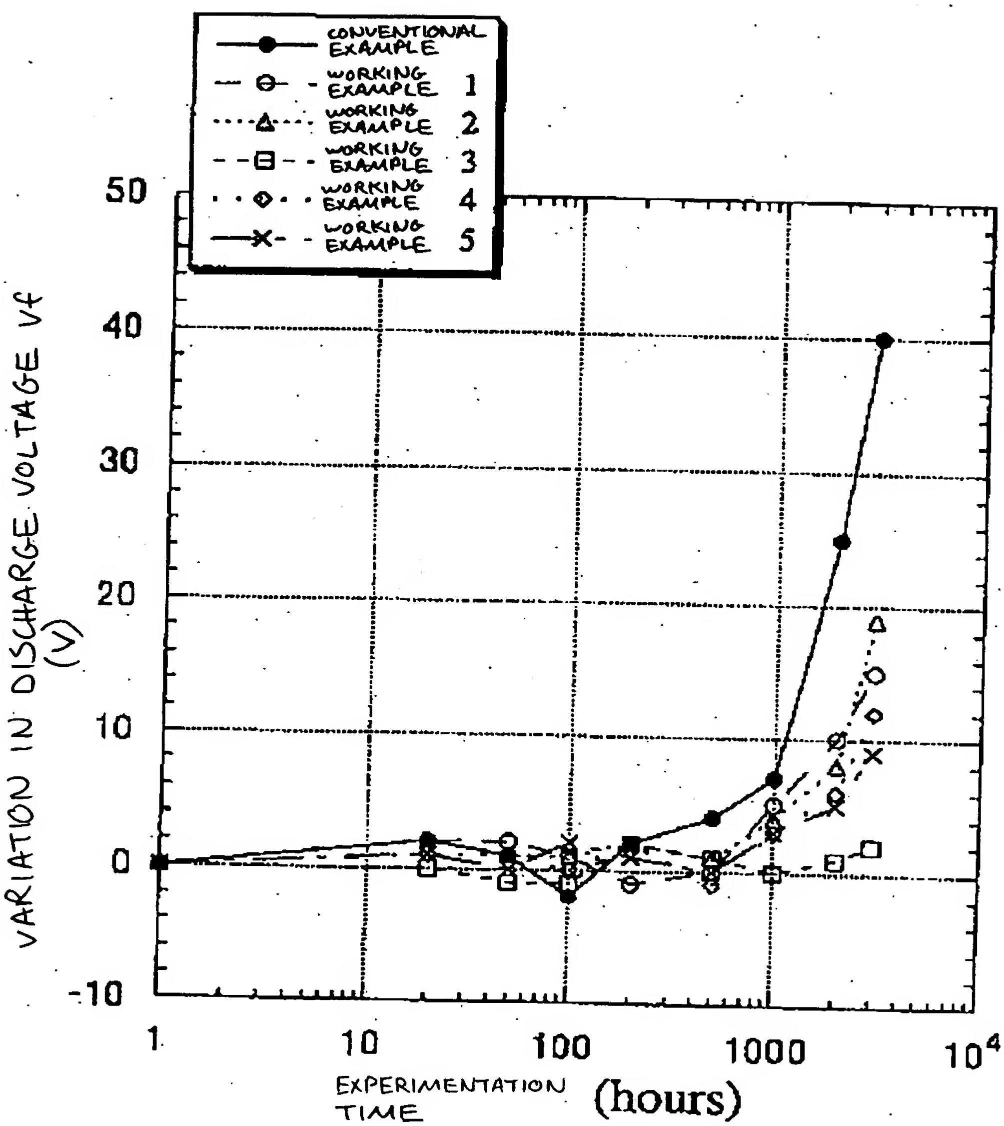
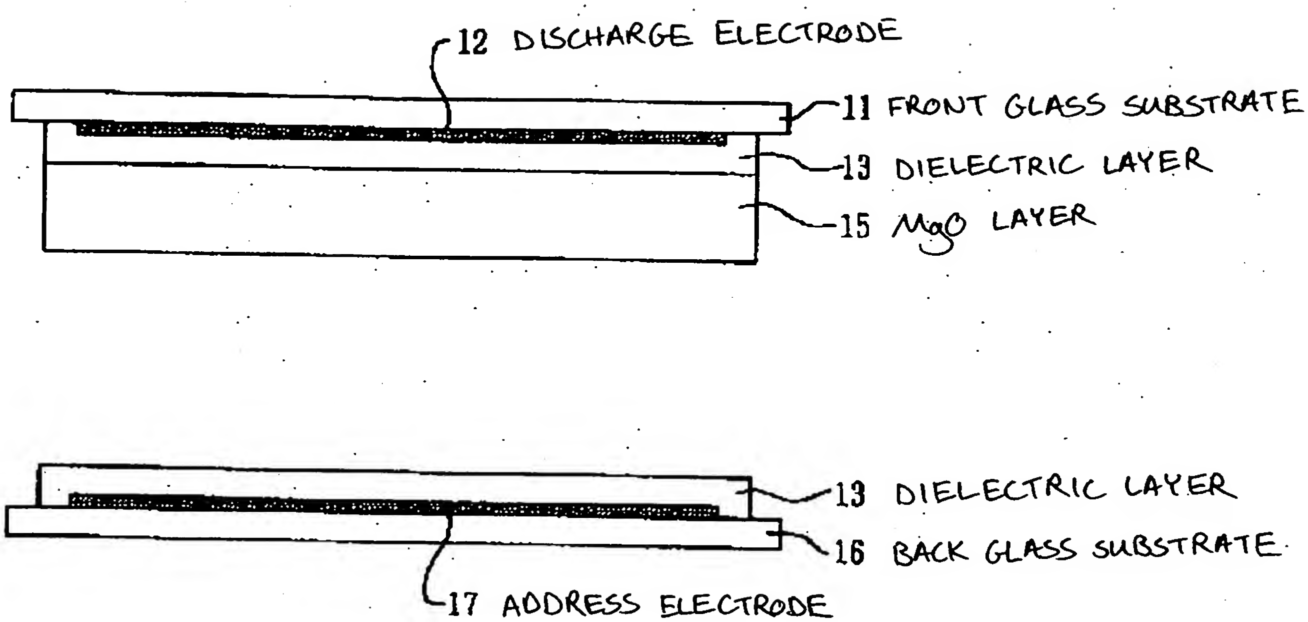


FIG. 3



CONVENTIONAL EXAMPLE
WORKING EXAMPLE 1
WORKING EXAMPLE 2
WORKING EXAMPLE 3
WORKING EXAMPLE 4
WORKING EXAMPLE 5
VARIATION IN DISCHARGE VOLTAGE Vf (V)
50
40
30
20
10
0
-10
1
10
100
1000
10^4
EXPERIMENTATION TIME (hours)

FIG. 4



12 DISCHARGE ELECTRODE
11 FRONT GLASS SUBSTRATE
13 DIELECTRIC LAYER
15 MgO LAYER
13 DIELECTRIC LAYER
16 BACK GLASS SUBSTRATE
17 ADDRESS ELECTRODE